SUPPLEMENT
TO
SALT RIVER SUBBASIN ASSESSMENT AND TOTAL MAXIMUM DAILY LOADS
(DEQ 2017)

DEVELOPMENT OF SEDIMENT WASTELOAD ALLOCATIONS FOR THE SMOKY CANYON MINE USING MULTIPLE NON-LINEAR REGRESSION EQUATIONS FOR UNGAGED STREAMS AND RIVERS IN IDAHO (DATED JUNE, 2017)

OVERVIEW AND PURPOSE

Smoky Creek (AU D17040105SK007_02c) is a tributary within the Salt River Subbasin (HUC 17040105) located in southeastern Idaho (see **Figure 1** below). The Idaho Department of Environmental Quality (DEQ) identified Smoky Creek as being impaired (Category 5) by excess sediment within the 2012 Integrated Report. A draft Total Maximum Daily Load (TMDL) developed for the Salt River Basin by DEQ was submitted to the Environmental Protection Agency (EPA) in August 2015 without a stormwater WLA for the Smoky Creek Mine (SCM). Upon review, EPA indicated that inclusion of the WLA was necessary for approval of the TMDL. Subsequently, and with assistance from EPA, a sediment wasteload allocation (WLA) has been developed and through this Supplement is assigned to the SCM and included in the Salt River subbasin TMDL.

In a letter dated April 1, 2016, JR Simplot (SCM permittee) expressed concerns with a previous, simplified approach used to determine the TMDL WLA for the SCM. In this letter, JR Simplot asked IDEQ to consider seasonal changes in sediment export from the site rather than dividing an annual WLA value by 365. In response to comments raised by JR Simplot, EPA Region 10 and DEQ applied seasonal non-linear regression equations developed by the US Geological Survey (‘Regression Method’, Hortness and Berenbrock 2001) to develop sediment WLAs for the SCM. This document summarizes rationale for model selection and application in developing daily sediment WLAs for the SCM. Specific language changes within the TMDL document can be viewed at www.deq.idaho.gov/salt-river-subbasin.

Development of Sediment Wasteload Allocations for the Smoky Canyon Mine using multiple non-linear Regression Equations for Ungaged Streams and Rivers in Idaho.

Overview and Purpose

Smoky Creek (AU D17040105SK007_02c) is a tributary within the Salt River Subbasin (HUC 17040105) located in southeastern Idaho (see Figure 1 below). The Idaho Department of Environmental Quality (IDEQ) identified Smoky Creek as being impaired (Category 5) by excess sediment within the 2012 Integrated Report. Smoky Creek Mine (SCM) is a contributor of sediment to Smoky Creek. Seasonal non-linear regression equations developed by the US Geological Survey (‘Regression Method’, Hortness and Berenbrock 2001) was applied to develop sediment WLAs for the SCM. Detailed description of the rationale for model selection and application in developing daily sediment WLAs for the SCM is provided below.

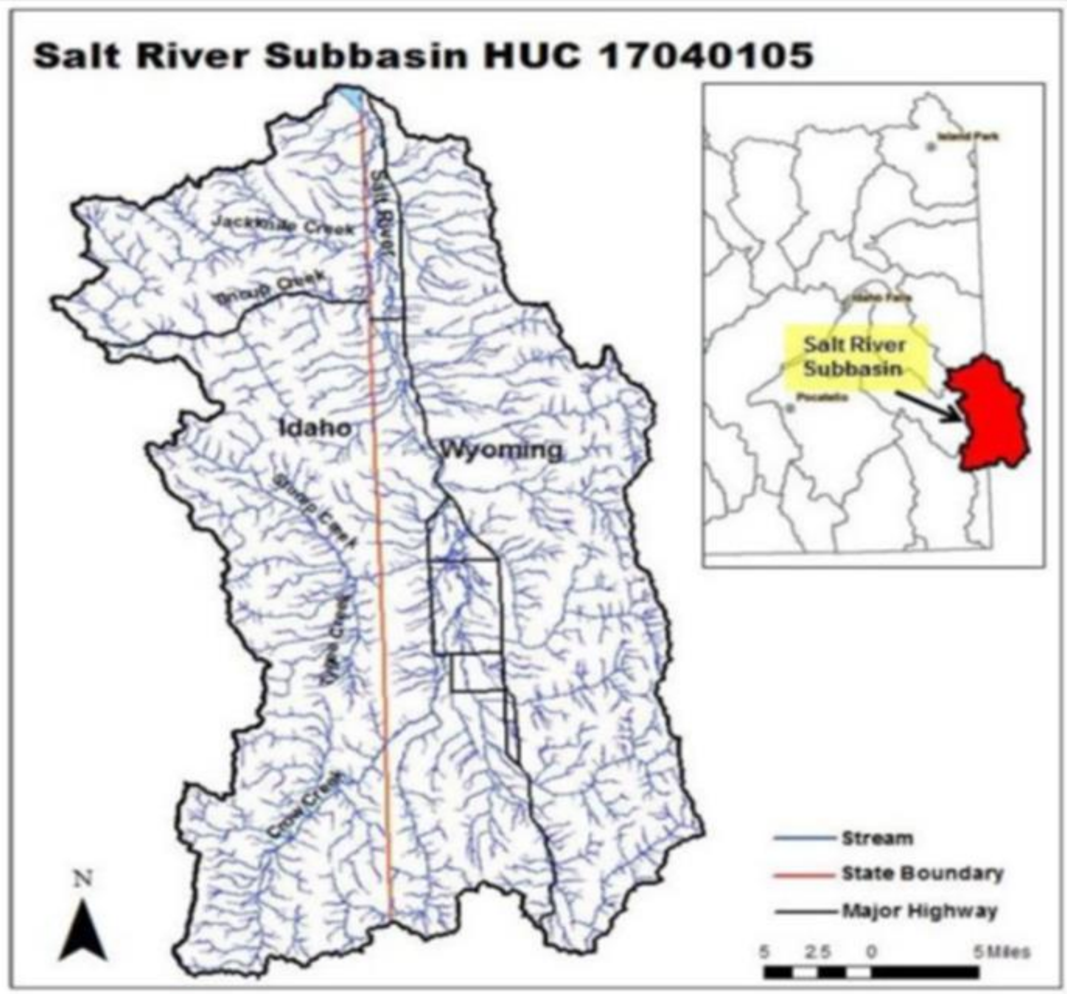

Figure 1. Salt River subbasin.

Figure H-1. Salt River Subbasin.

Model Description and Selection

The Regression Method includes a set of multiple non-linear regression equations that predict various flow statistics at ungaged locations in Idaho. Equations were developed from statistical analysis of flow records collected at 200 stream gages for the period of 1955-2000. Monthly and annual regression equations were developed for eight different regions to capture physiogeographic patterns affecting hydrologic response. The SCM is located in Region 8 (southeast Idaho) as delineated by Hortness and Berenbrock (2001) and contains 31 of the 200 gaging stations analyzed as part of the study. A flow statistic of interest for developing SCM WLAs is the Q_{50}. The Q_{50} (median flow magnitude) represents a central tendency flow value that when multiplied by an applicable water quality standard would result in a daily allowable load that on average, would achieve water quality standards.

The Regression Approach includes equations that predict the Q_{50} for each month in Region 8 based on 3 or more independent variables (Table 1). The Regression Approach was selected because: (1) daily loads determined from predicted monthly Q_{50} values capture seasonal patterns requested by permittee and (2) is based on sound science and physical data applicable to streams and rivers in and around the SCM.

Table H-1. Regional Regression Models Derived from Daily Flow Data in Region 8 delineated by Hortness and Berenbrock (2001).

Month	Equation	Description of Input Variables
October	$Q_{50} = 1.04E\text{-}05 \times A^{1.08} \times F^{*-0.999} \times P^{4.09}$	Q_{50}: Median daily average flow (cfs) A: Drainage area (mi^2) F*: Forested area (% A + 1) P: Mean annual precipitation (in) E*: Mean basin elevation (1000 feet ASL) BS: Basin slope (%) S30*: Slopes > 30 percent (% A + 1)
November	$Q_{50} = 2.11E\text{-}05 \times A^{1.07} \times F^{*-0.999} \times P^{3.89}$	
December	$Q_{50} = 2.02E\text{-}02 \times A^{1.02} \times E^{*-3.52} \times F^{*-0.824} \times P^{3.83}$	
January	$Q_{50} = 5.20E\text{-}02 \times A^{1.01} \times E^{*-3.81} \times F^{*-0.853} \times P^{3.76}$	
February	$Q_{50} = 5.90E\text{-}02 \times A^{1.01} \times E^{*-3.78} \times F^{*-0.864} \times P^{3.71}$	
March	$Q_{50} = 1.77E\text{-}01 \times A^{0.975} \times E^{*-3.67} \times F^{*-0.788} \times P^{3.33}$	
April	$Q_{50} = 8.65E{+}02 \times A^{0.835} \times E^{*-5.11} \times BS^{0.210} \times P^{1.07}$	
May	$Q_{50} = 1.06E{+}01 \times A^{0.908} \times E^{*-3.26} \times BS^{0.412} \times P^{1.28}$	
June	$Q_{50} = 4.37E\text{-}05 \times A^{1.10} \times BS^{0.838} \times F^{*-0.899} \times P^{3.31}$	
July	$Q_{50} = 7.85E\text{-}06 \times A^{1.17} \times S30^{*0.586} \times F^{*-0.716} \times P^{3.44}$	
August	$Q_{50} = 1.17E\text{-}06 \times A^{1.16} \times S30^{*0.514} \times F^{*-1.05} \times P^{4.26}$	
September	$Q_{50} = 1.31E\text{-}05 \times A^{1.05} \times F^{*-0.838} \times P^{3.90}$	

Model Application and Approach

The area of SCM included in this analysis is 492 acres. The watershed boundary was delineated by hand in ArcGIS using a 10 m Digital Elevation Model (DEM) and is shown as a dark black outline. The mine area modeled with Regression Method is the crosshatched area in Figure 2 below. The mine panel boundaries were obtained from JR Simplot in the form of a GIS shapefile. Regression inputs in Table 1 were derived directly for the mine area using ArcGIS tools including Spatial Analyst. Model inputs and their sources are summarized below in Table 2.

Model Results

Median daily average flow (Q_{50}) values predicted by the Regression Method (Figure 3) are reasonable because: (1) values are greater for wet months compared to dry months (i.e., reflect expected seasonal patterns) and (2) are based on physical data collected within the region containing the SCM.

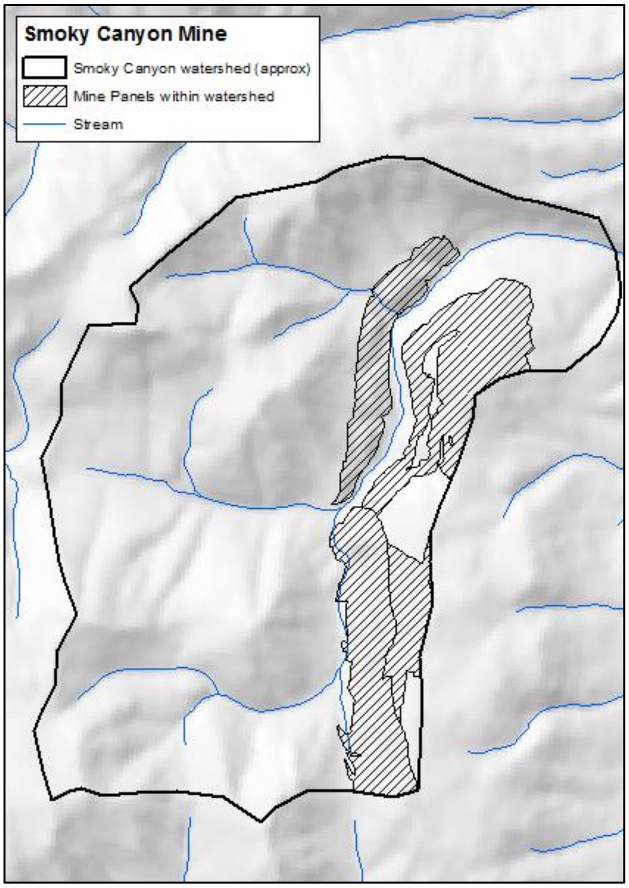

Figure H-2. Smoky Creek Watershed Boundary (approximate) and Smoky Creek Mine Panel Boundaries.

Table H-2. Regression Method Input Values and Data Source

Parameter	Data Source	Value[1]	Comments
Annual Precipitation (P)	*http://www.prism.oregonstate.edu/explorer/*	26.8 inches	A 20-year mean annual precipitation for 1996-2015.
Slope characteristics (BS and S30*)	30 m DEM *https://www.sciencebase.gov/catalog/*	BS = 26.4% S30*= 41%	Slope of each mining panel was calculated in ArcGIS using the Zonal Statistics tool. The slope raster file used in the Zonal Statistics tool was derived from a 30 m DEM.
Drainage Area (A)	JR Simplot	0.77 mi^2	ArcGIS analysis of shapefile provided by permittee
Forested Area (F*)	National Agricultural Statistics Service (NASS) CropScape website (*https://nassgeodata.gmu.edu/CropScape/*)	71%	State of Idaho Statute 47-1510. A pre-mining distribution of 70% Forest and 30% Shrub was determined from land cover (2015) datasets using ArcGIS analysis
Mean Basin Elevation (E*)	30 m DEM *https://www.sciencebase.gov/catalog/*	7.22	Mean elevation for mining panels determined in ArcGIS using the zonal statistics tool.

Note that values are in units required by regression equations

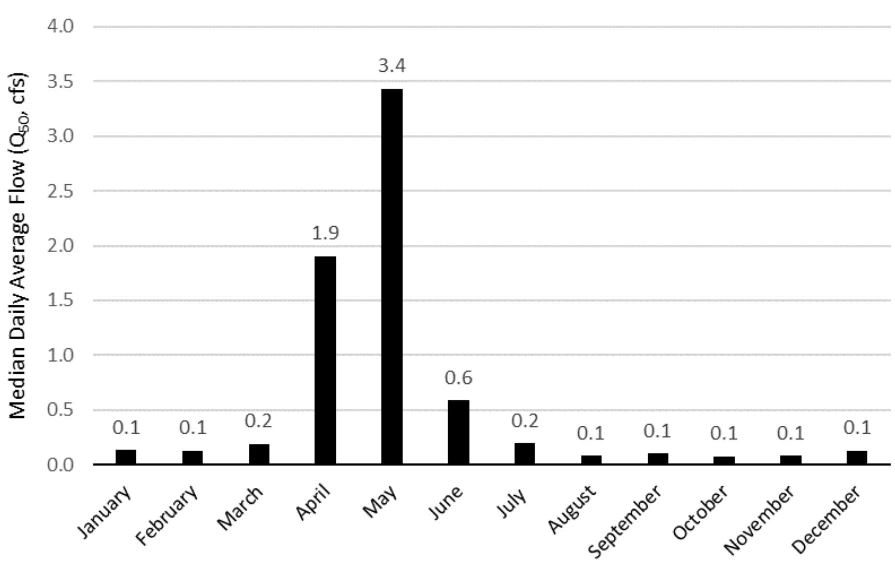

Figure H-3. Median Average Daily Flow (Q_{50}) Predicted by Regression Method by Month for Smoky Creek.

Wasteload Allocation Derivation

Wasteload allocations are defined at 40 CFR 130.2(h) as the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Load capacity is the greatest amount of loading that a water can receive without violating water quality standards (40 CFR 130.2(f)). The approach used to develop sediment WLAs for the SCM is summarized as follows and described in subsequent paragraphs:

- Quantify the level of suspended sediment that is equivalent to existing Idaho turbidity water quality standards (e.g., turbidity surrogate or sediment target);
- Develop allowable daily load dataset by multiplying watershed discharge (from regression equations) by the sediment target; and
- Express daily load by month, flow condition, or other appropriate basis to develop WLAs according to daily load guidance (EPA 2007).

A. Target Sediment Concentration

Aquatic life uses presumed or existing in Smoky Creek include protection of cold water aquatic life and salmonid spawning (TMDL page 9). The Idaho Administrative Code at 58.01.02.250(02)e includes the following turbidity criteria to protect cold water aquatic life:

"*Turbidity, below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than fifty (50) NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days.*"

The average component of the turbidity criterion (i.e., a change of 25 NTU) was used as a water column target for development of WLAs from the mine. The following linear regression relating turbidity to total suspended solids (TSS) was provided by IDEQ (**Equation 1**):

Equation 1: TSS (as mg/L) = 1.7805*Turbidity (as NTU) + 2.9388 ($r^2 = 0.86$, n= 16)

Using **Equation 1**, a change of 25 NTU was converted to a change in TSS of 44.5 mg/L. Put in another way, an increase in TSS concentration of 44.5 mg/L will result in an increase of 25 NTU relative to upstream (i.e., background) conditions.

B. Allowable Load Dataset

The allowable load dataset (as lbs/day) was developed according to **Equation 2** below.

Equation 2: Water Quality Target * Median Discharge * Conversion Factor = Allowable Daily Load

44.5 mg/L TSS * Monthly Q_{50} * 5.395 = Monthly Allowable Median Daily Load (lbs/day)

Application of regression based methods to derive allowable daily loads is included within EPA (2007) guidance.

C. Wasteload Allocation

EPA guidance (EPA 2007) includes multiple options for expressing allowable loads. These options, or expression schemes, include aggregation of allowable loads on a seasonal, monthly, or flow frequency basis. Wasteload allocations for the SCM were developed on a monthly central tendency basis (**Table 3**). A monthly approach addresses seasonality as requested by permittee.

Table H-3. Monthly Sediment (as Total Suspended Solids) Wasteload Allocations for the Smoky Canyon Mine Based Regression Method

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Allowable Load*	lbs/day	31.6	30.8	45.9	457.9	824.9	140.9	47.1	19.2	24.9	18.4	19.4	30.9

*To be implemented as the median daily load for a given month

References

Hortness, J. and Berenbrock, C. 2001. Estimating Monthly and Annual Streamflow Statistics at Ungaged Sites in Idaho. Water-Resources Investigations Report 01–4093. US Geological Survey, Boise, ID.

U.S. Environmental Protection Agency (EPA). 2007. Draft Guidance: Options for Expressing Daily Loads in TMDLs Options for Expressing Daily Loads in TMDLs. Office of Wetlands, Oceans & Watersheds, Washington DC.